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Effect of Gamification on the Development of Digital Competencies of Regular Basic Education Teachers

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Abstract. In the digital age, teachers' digital competencies are important for effective education, yet many educators, particularly in Latin America, lack these essential skills. While gamification has shown promise in various education contexts, its effectiveness for developing teachers' digital competencies remains understudied, especially in the Latin American setting. This study aimed to examine the effect of gamification on the development of digital competencies of basic education teachers in Trujillo, Peru. A quasi-experimental design was used, and 60 primary-level teachers were selected through convenience sampling; they were randomly assigned to either an experimental (n = 30) or control (n = 30) group. The experimental group participated in a two-month program consisting of 15 gamified sessions, whereas the control group received no intervention. Data were collected via an adapted version of the Teacher Digital Competence Questionnaire in pretest and posttest phases. Descriptive statistics, Mann-Whitney U tests, and Kruskal-Wallis tests were employed for data analysis. The results reveal significant improvements in the experimental group's digital competencies across all dimensions (information literacy, communication, content creation, safety, and problem-solving), with 93.3% achieving the "achieved" level postintervention, compared with 30% of the control group. Inferential analysis confirms significant differences between groups in the posttest phase (Mann-Whitney U = 96.5, $p < .05$). These findings suggest that gamification is an effective strategy for developing teachers' digital competencies, and can contribute valuable empirical evidence to the field of education technology and holds important implications for teacher training and education policies in Latin America.

Keywords: Gamification; Digital Competencies; Teacher Training; Quasi-Experimental Design; Basic Education

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1. Introduction

In the current era of knowledge, digital competence has become an essential skill for human and professional development. This competence enables individuals to acquire, process, and transmit information, and to transform it into useful knowledge (Roll & Ifenthaler, 2021). In the education field, a challenge for teachers is mastering the necessary skills to manage virtual learning environments and improve their pedagogical practices through the effective use of digital technologies.

The COVID-19 pandemic accelerated the need for teachers to develop digital competencies to carry out their pedagogical work in virtual learning environments. According to Santos et al. (2021), these competencies are essential for meeting both the technological demands of today's digital society and students' increasing use of digital tools for learning, communication, and collaboration. During the pandemic, many teachers realized they were not adequately prepared to use online or remote educational strategies and methods, which highlighted the importance of providing pedagogical support through various formative tactics (Trust & Whalen, 2020).

A significant gap in teachers' digital competencies has been identified, and this gap applies all over the world. The OECD (2020) indicates that the main challenges facing improving the learning of teachers are a lack of connectivity, capacity, and digital skills. In Brazil, 41% of teachers lack digital tools for teaching; in Ecuador, 54% do not possess digital skills for problem-solving; and in Mexico, more than 50% of teachers aged 25–54 years have very low digital competencies. These data reveal a common issue in various countries, and underscores the need to implement effective strategies to develop digital competencies in teachers.

Gamification is emerging as a promising strategy for developing digital competencies of educators. Gamification is defined as the application of game design elements in nongaming contexts (Barragán-Pulido et al., 2023), and has proven to be effective in enhancing motivation, engagement, and learning in various education settings. Recent studies suggest that gamification tools can be effective in cultivating critical digital skills, such as information literacy and ICT (information and communication technology) competencies, which are essential for modern educators (Sabbah & Sabbah, 2023). Furthermore, gamification has the potential to improve teachers' emotional intelligence, which is crucial for managing classroom dynamics and fostering a positive learning environment (Soboleva et al., 2023). However, the effective implementation of gamification involves challenges, including the need for adequate training and the availability of digital tools (Araujo & Carvalho, 2017). Despite these obstacles, gamification offers an innovative approach to addressing the gap in educators' digital competencies, especially in contexts such as Latin America, where the need to enhance these skills is particularly pressing.

Despite the growing importance of digital competencies in education, there remains a significant gap in understanding how to develop these skills effectively in elementary school teachers, particularly in the Latin American context. While gamification has shown promise in various education settings, its specific

effectiveness in enhancing teachers' digital competencies has been underexplored. This gap in knowledge is particularly critical in countries such as Peru, where, according to the OECD report (2022), only 10% of teachers possess an adequate level of digital competence for content creation. The urgency to address this issue is heightened by the rapid digitalization of education and increasing technological demands in the classroom.

In the Peruvian context, the problem of teachers' digital competencies is similar to the international trend. According to an OECD report (2022), only 10% of teachers in Peru have an adequate level of digital competence development to create digital content, and more than 50% need to improve their technology skills. According to the Ministry of Education of Peru (2019), 55% of teachers lack the skills to use virtual technologies, and 72.9% of educators in public schools have not been trained to used technologies to facilitate student learning. These data reflect a concerning situation regarding the digital competence levels of Peruvian teachers.
In the current educational landscape, teachers face significant motivational challenges as they recognize the importance of integrating digital tools into their teaching practice while simultaneously feeling inadequately prepared to use these technologies effectively. Many educators, especially in Latin America, find themselves in a difficult position: on the one hand, they recognize the growing importance of technology in education but, on the other hand, they lack the necessary digital skills to integrate it effectively into their teaching practice. Recent studies, such as that by Giménez and Orosco (2021), reveal that, in Peru, only 42.5% of teachers are capable of creating digital content, whereas only 50.2% can navigate and search for information online. This gap in digital competencies affects the quality of teaching, and negatively impacts teachers' motivation, as they may feel inadequate or resistant to technological change.

To address this issue, our research focused on the application of specific gamification methods to develop teachers' digital competencies. The implemented program consisted of 15 gamified sessions, each lasting 90 minutes, distributed over two months. These sessions incorporated game elements such as points, badges, leaderboards, and progressive challenges and were designed to foster participation and active learning. The activities focused on developing skills in key areas, such as using online collaboration tools, creating digital content, ensuring internet security, and solving technological problems.

This research aimed to fill a significant gap in the literature. While gamification has been studied in various education contexts, its specific effectiveness in developing the digital competencies of basic education teachers in Latin America has not been sufficiently explored. In this context, our study is guided by the following research questions: 1) To what extent does a gamification program improve the digital competencies of basic education teachers in Trujillo, Peru? 2) Which specific dimensions of digital competencies (information and informational literacy, communication and collaboration, digital content creation, security, and problem-solving) had improved the most after the gamified intervention?

The justification for this study is based on various perspectives. From a theoretical perspective, the importance of digital competencies in teachers to improve learning is recognized. Understanding these competencies broadly is crucial to addressing current and future education needs in a digitalized environment.

From a practical perspective, this study sought to offer concrete solutions through the implementation of gamification as a strategy to develop teachers' digital competencies. The choice of implementing a gamification-based intervention is justified by a persistent challenge in many education institutions: teachers' reluctance to engage with traditional professional development programs for digital skills enhancement, despite recognizing the growing importance of these competencies in education. This intervention approach specifically addressed the motivational aspects of teacher training through game-like elements that can make the learning process more engaging and effective.

From a methodological perspective, reliable and validated tools were used, thereby ensuring clear and precise results. These results not only contribute to the academic debate but also serve as a reference for future studies in the field of digital education.

Finally, from a social perspective, the study addressed two important dimensions: the lack of digital knowledge in teachers, which is a significant social problem in the country's education institutions, and the constant need for teachers to demonstrate quality through continuous skill and knowledge development, which reinforces the relevance and pertinence of the study in the Peruvian context of today.

2. Literature Review

2.1. Review of Digital Competence in Teachers

Digital competence has become a fundamental element of the professional profile of 21st-century teachers. This competence is defined as the set of knowledge, skills, and attitudes that are needed to effectively and critically use ICTs in the education context (Redecker, 2017). The importance of the digital competence of teachers lies in their ability to enhance teaching and learning processes and prepare students for the demands of a digital society.

The European Framework for the Digital Competence of Educators (DigCompEdu) provides a comprehensive structure for understanding and assessing teachers' digital competence. This framework identifies six key areas: professional engagement, digital resources, teaching and learning, assessment, empowering learners, and facilitating learners' digital competence (Redecker & Punie, 2017). Each of these areas encompasses specific competencies that teachers must develop to effectively integrate technologies into their pedagogical practice.

Research has found that the level of teachers' digital competence significantly influences the quality of teaching and the development of students' digital skills. A study by Fernández-Batanero et al. (2020) found that teachers with higher levels of digital competence tend to use a wider variety of technological tools and strategies in the classroom, leading to richer and more diverse learning experiences for students.

However, various studies have identified significant gaps in teachers' digital competencies in various countries. Instefjord and Munthe (2017) report that many teachers feel insecure about using technologies in the classroom and lack the necessary skills to integrate them effectively in their pedagogical practice. This gap became even more evident during the COVID-19 pandemic, when education systems were forced to adopt remote teaching modalities (König et al., 2020).

Continuous professional development plays an important role in strengthening teachers' digital competencies. Tejada and Pozos (2018) argue that teacher training programs should adopt comprehensive approaches that focus not only on technical skills but also on the pedagogical competencies needed to use technologies effectively in the classroom. These authors propose a training model based on critical reflection and situated practice, which would enable teachers to develop their digital competencies in real teaching contexts.

Despite these advances, significant challenges remain regarding the development of teachers' digital competencies. One of the main challenges is the rapid evolution of technologies, which requires constant updating of teachers' skills and knowledge. Additionally, factors such as a lack of resources, limited time, and institutional barriers can hinder the development of digital competence in many education contexts (Voogt et al., 2018).

2.2. Gamification as a Strategy to Develop Digital Competence in Teachers

Gamification has emerged as an innovative and promising strategy to develop digital competencies in teachers. This methodology, which involves the application of game elements and mechanics in nongame contexts, has been shown to have a positive effect on participants' motivation, engagement, and learning (Deterding et al., 2011). In the context of teacher training, gamification offers an attractive and effective approach to addressing the challenge of developing digital competencies in an ever-evolving education environment.

The application of gamification in teacher training is based on learning theories such as constructivism and connectivism. These theories emphasize the importance of active participation, social interaction, and knowledge construction in meaningful learning environments (Siemens, 2005). Gamification provides a framework within which teachers can experiment, reflect, and apply new digital skills in a safe and motivating environment.

The strategies employed in gamification for developing digital competencies in teachers are diverse and carefully designed. One of the most common approaches is the use of points, badges, and leaderboards (Werbach & Hunter, 2012). Points are awarded for completing specific tasks related to digital skills, badges recognize particular achievements, and leaderboards foster healthy competition among participants. Progressive challenges are implemented and gradually increase in difficulty, to stimulate teachers to develop their competencies in a stepped manner (Kapp, 2012).

Narrative and storytelling are essential elements of these strategies, by contextualizing learning activities in realistic educational scenarios (Sailer et al.,

2017). For example, virtual missions can be created that require teachers to solve technology-related problems in a simulated classroom by applying their digital skills in practical situations. This approach not only enhances engagement but also provides a context that closely mirrors real-world teaching challenges.

Empirical research on the effectiveness of these gamification strategies has shown promising results. Several studies have explored the potential of gamification to enhance teachers' digital competencies. For example, Kopcha et al. (2016) implemented a gamified training program to develop the technology skills of primary school teachers. The results reveal significant improvements in participants' self-efficacy and technology skills, as well as a greater willingness to integrate technology in their teaching practices. Specifically, the participants showed a 35% increase in confidence for using educational technology after the intervention.

Hsu and Lin (2017) designed a gamified system to improve teachers' skills through the use of Web 2.0 tools. The study reveals that incorporating elements such as points, badges, and leaderboards significantly increased participants' motivation and mastery of digital tools. Their findings indicate a 28% increase in teacher motivation and a 42% improvement in their digital skills, which suggests that gamification not only enhances technical competencies but also addresses important motivational aspects of teachers' professional development.

One of the key aspects of gamification is its ability to provide immediate and personalized feedback. Tsai et al. (2020) developed an adaptive gamified learning system for teacher training in digital competencies. The system dynamically adjusts the difficulty level and content on the basis of individual performance, resulting in significant improvements in participants' digital skills.

Gamification can also promote collaboration and peer learning, which are crucial aspects of the professional development of teachers. A study conducted by Palazón-Herrera (2021) implemented a gamified approach to promote online collaboration among trainee teachers. The results reveal an increase in participation and the quality of interactions, as well as an improvement in participants' digital communication skills.

However, it is important to note that not all studies have reported uniformly positive results. Kyewski and Krämer (2018) report that using badges did not have a significant effect on participants' performance in an online course, which suggests that the effectiveness of gamification elements may vary according to context and implementation. This highlights the need for careful design and alignment with specific learning objectives when implementing gamification strategies.

The theoretical framework underpinning this study is primarily based on the connectivism theory proposed by Siemens (2005). This theory emphasizes learning as a process of connecting specialized nodes or information sources, which is particularly relevant in the context of gamification for digital competence development, as it recognizes the importance of networks and technology in the learning process.

Additionally, the self-determination theory of Ryan and Deci (2000) informs the design of gamification strategies, and focuses on satisfying the basic psychological needs of autonomy, competence, and relatedness to foster teachers' intrinsic motivation in relation to their digital professional development.

The effective implementation of gamification requires careful design and clear alignment with learning objectives. Sailer and Homner (2020), in a meta-analysis on the effectiveness of gamification in education, emphasize the importance of selecting appropriate and contextually relevant game elements to maximize learning benefits. They report that, while gamification generally has positive effects on cognitive, motivational, and behavioral learning outcomes, the specific impact varies, depending on the context and the learner.

Moreover, gamification should be considered part of an holistic approach to the development of teachers' digital competencies. Romero-Rodríguez et al. (2019) argue that gamification should be integrated with other training strategies and accompanied by adequate institutional support to achieve a sustainable impact on teaching practices. This finding suggests that, while gamification can be a powerful tool, it should be part of a broader, comprehensive approach to teacher professional development.

In conclusion, gamification offers a promising approach to developing digital competencies in teachers. Its ability to increase motivation, provide immediate feedback, and foster collaboration makes it a valuable tool in teacher training programs. The combination of gamified strategies supported by empirical evidence and grounded in contemporary learning theories provides a solid framework for addressing the development of digital competencies of basic education teachers. However, its implementation must be based on sound pedagogical principles and tailored to the specific needs of the education context. Future research should explore the long-term effectiveness of gamified approaches and their impact on classroom teaching practices, as well as the specific gamification elements that are most effective for each dimension of teachers' digital competence.

3. Method

To respond to the research objective, a quasi-experimental study was designed to evaluate the influence of gamification on the development of digital competencies of regular basic education teachers, following the recommendations of Hernández-Sampieri and Mendoza (2018) for this type of design.

The choice of a quasi-experimental design was justified by several factors. First, it allows for the comparison of a treatment group (receiving gamified training) with a control group (not receiving the intervention) in a real-world education setting, which is crucial for understanding the practical effectiveness of gamification in teacher training. Second, the quasi-experimental design accommodated the ethical and practical constraints of the study, as random assignment of individual teachers to conditions was not feasible, because of institutional constraints and the

need to work with intact groups. This approach aligns with the recommendations of Shadish et al. (2002) for educational research, where full randomization is not possible.

3.1. Participants

Participants were recruited from two public education institutions in the city of Trujillo, Peru. A non-probabilistic convenience sampling method was used, justified by the accessibility and availability of the teachers, as well as the voluntary nature of participation (Etikan et al., 2016). The total sample consisted of 60 primary-level teachers, with ages ranging between 30 and 50 years.

To account for potential confounding factors, data on participants' ages, teaching experience, prior exposure to technology, and initial level of digital competence were collected. These factors were analyzed to ensure comparability between the experimental and control groups. The age distribution was similar for the two groups, with a mean age of 41.3 years (SD = 7.2) in the experimental group and 40.8 years (SD = 6.9) in the control group. Teaching experience ranged from 5 to 25 years, with no significant difference between groups ($t(58) = 0.87$, $p > .05$).

Prior exposure to technology was assessed via a self-report questionnaire, which revealed that 65% of the participants in both groups had basic to intermediate technology skills. The initial level of digital competence was measured via pretest scores, which revealed no significant differences between groups (Mann-Whitney $U = 379.5$, $p > .05$), thereby ensuring a comparable baseline for the study.

All participants signed informed consent before the study started and were informed that they could withdraw at any time; we followed the ethics principles proposed by Sanjari et al. (2014) for education research.

3.2. Experimental Procedure

The experimental procedure was carried out in three main phases. In the first phase, a pretest evaluation was administered to both the experimental ($n = 30$) and control groups ($n = 30$). Administering the pretest to both groups was essential to establish a comparable baseline and ensure initial equivalence in terms of digital competencies. All participants completed a 54-item questionnaire on digital teaching competence, which had been adapted from the Digital Teaching Competence Questionnaire (CDD) developed by Tourón et al. (2018).

In the second phase, one of the researchers provided the experimental group with a detailed explanation of the nature of the experiment, including a thorough description of the gamified activities that would be used to develop their digital competencies. This explanation followed the recommendations of Dicheva et al. (2015) for implementing gamification in education. The participants were given the opportunity to ask questions and clarify any doubts before starting the program.

The participants in the experimental group subsequently attended 15 gamified sessions that were designed to develop their digital competencies. Each session

lasted 90 minutes and was designed according to the gamification principles proposed by Kapp (2012). These sessions were led by a team of three instructors, all university professors with extensive experience in educational technology and teacher training. To ensure consistency in program implementation, the same team of instructors worked exclusively with the experimental group throughout the intervention, rotating between sessions to cover different aspects of digital competencies.

The control group, by contrast, did not receive this gamified intervention and continued with their usual professional development activities. After each session, the teachers in the experimental group presented evidence of their work and participated in brief interviews to share their impressions and experiences.

In the third, final phase, a posttest evaluation was conducted. All participants, of both the experimental and control groups, completed the digital teaching competence questionnaire again to measure the development of their skills.

This approach, which included both pretest and posttest evaluations for both groups, enabled a rigorous comparison of the impact of the gamified intervention on the development of teachers' digital competencies. It also controlled for any initial differences between the groups, to provide a solid foundation for subsequent statistical analysis.

3.3. Program Duration

The program lasted approximately two months (from May 2 to July 5, 2024) and was part of a continuous professional development program for teachers. A total of 15 gamified sessions, each lasting 90 minutes, were conducted. These sessions were divided into five learning units aimed at developing digital competence both at the general level and for each of its dimensions, following the DigCompEdu framework (Redecker, 2017).

All the sessions were conducted via the Google Meet platform, which allowed teachers to use digital tools and participate in gamified activities throughout the program.

3.4. Instruments

An adaptation of the CDD as developed by Tourón et al. (2018) was used, which consists of 54 items with a five-point Likert scale ranging from (1) Never to (5) Always. The dimensions of digital competence measured in the questionnaire are information and information literacy (8 items), communication and collaboration (9 items), digital content creation (16 items), safety (8 items), and problem-solving (13 items).

To calculate the reliability of the measurement instrument, Cronbach's alpha reliability coefficient was used, where digital competence had a value of $\alpha = .897$, indicating high internal consistency according to the criteria of George and Mallery (2003). The content validity of the research instrument was established through expert judgment, whose evaluations yielded an Aiken's V coefficient

(V = .92) that demonstrates high content validity according to the standards proposed by Aiken (1985).

3.5. Methods of Data Collection and Analysis

In total 60 prequestionnaires and 60 postquestionnaires were collected. To address the research questions, the data were analyzed via descriptive and inferential statistical techniques, following the recommendations of Field (2017) for data analysis in the social sciences.

For data processing, descriptive statistics, including contingency tables, double bar charts, and box plots, were employed. Inferential statistics were also used, applying the Mann-Whitney U test for independent groups to determine the differences between the scores of the experimental and control groups. Additionally, the Kruskal-Wallis nonparametric test was used to determine the influence of gamification implementation on the development of digital competence across different dimensions in the posttest evaluation phase of the experimental group. The processing was performed via RStudio software, Version 4.3.2.

3.6. Skills to be Developed

The gamified intervention was designed to develop five key dimensions of digital teacher competencies according to the DigCompEdu framework (Redecker, 2017):

1. Information and information literacy: skills to search effectively, evaluate, and manage digital information;

2. Communication and collaboration: Skills to interact and collaborate in digital environments, share resources, and participate in online communities;

3. Digital content creation: Skills to develop and edit digital content in various formats, integrating and reworking previous knowledge;

4. Security: Skills to protect devices, personal data, health and the environment in digital environments; and

5. Problem-solving: Abilities to identify needs, solve technical problems and use digital tools creatively.

Each gamified session focused on developing specific aspects of these dimensions, to provide teachers with practical opportunities to improve their skills in relevant education contexts.

3.7. Study Variables

The study variables are defined as follows:

Independent variable: The gamification-based intervention, consisting of a 15-session program designed to develop digital competencies in teachers.

Dependent variable: The level of digital competence of teachers, measured through the five dimensions assessed in the CDD questionnaire (information and information literacy, communication and collaboration, digital content creation, safety, and problem-solving).

4. Results

Table 1. Scales and levels of the variable digital competencies of regular basic education teachers, as well as each of its dimensions, according to scores

Variable	Scale	Level
Digital competencies	[45–105]	Low
	[106–165]	Medium
	[166–225]	High
Dimensions	**Scale**	**Level**
Information and information literacy	[8–18]	Low
	[19–29]	Medium
	[30–40]	High
Communication and collaboration	[9–21]	Low
	[22–33]	Medium
	[34–45]	High
Digital content creation	[16–37]	Low
	[38–59]	Medium
	[60–80]	High
Security	[8–18]	Low
	[19–29]	Medium
	[30–40]	High
Problem-solving	[13–30]	Low
	[31–48]	Medium
	[49–65]	High

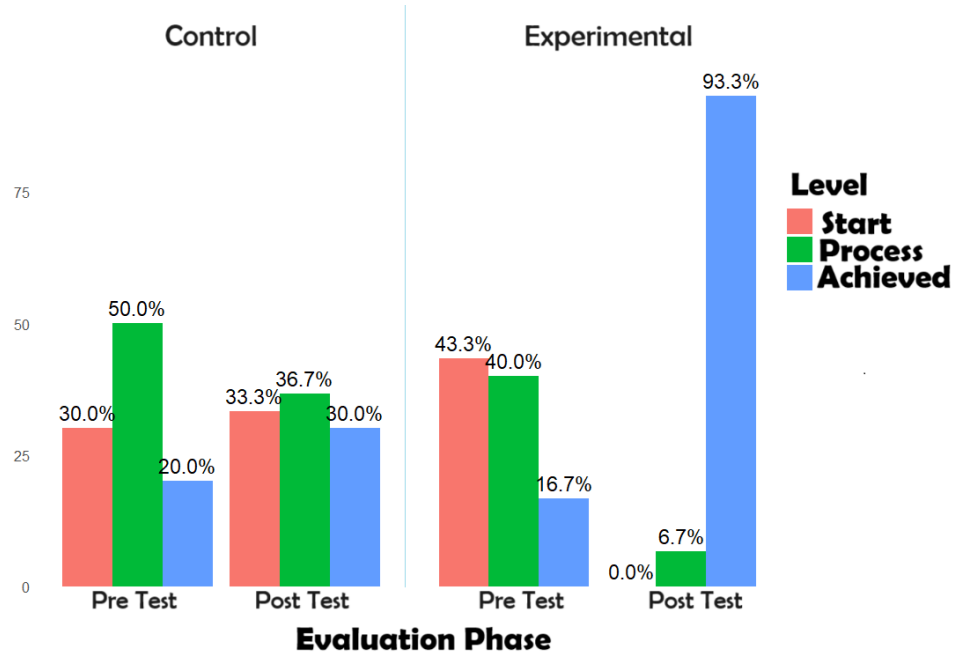

Figure 1: Percentage distribution of the results before and after application of gamification to develop digital competencies in regular basic education teachers, according to level

Table 1 and Figure 1 present the percentage distributions before and after applying gamification to develop digital competencies of regular basic education teachers, distinguishing between the control group and an experimental group in the evaluation phase, according to competence level (Initial, In Process, and Achieved). For the control group, the pretest results reveal that 30% of the teachers were at the initial level, 50% were at the process level, and 20% were at the achievement level. For the posttest group, these percentages changed to 33.3%, 36.7%, and 30%, respectively, indicating slight improvement. In turn, for the experimental group, the pretest results indicate that 43.3% of the teachers were at the initial level, 40% at the process level, and 16.7% at the achievement level; and after the intervention, the posttest results reveal significant progress, with 0% at the initial level, 6.7% at the process level, and 93.3% at the achievement level. These results suggest that gamification had a considerable positive effect on the development of their digital competencies, especially compared with the control group, whose progress was less pronounced.

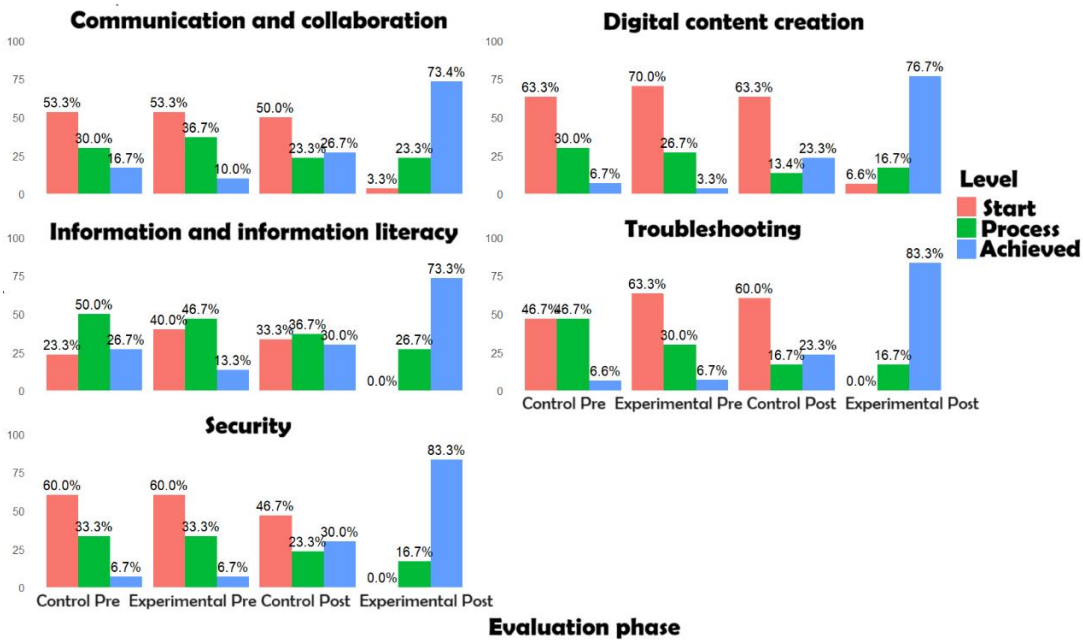

Figure 2: Grouped percentage distributions before and after the application of gamification to develop each of the dimensions of the variable digital competencies in regular basic education teachers in the evaluation phase, according to level

The interpretation of Figure 2 provides a detailed view of the effect of gamification on the development of digital competencies of basic education teachers over five dimensions: information and information literacy, communication and collaboration, digital content creation, safety, and problem-solving. By comparing the pre- and postimplementation evaluations of the control and experimental groups, a marked trend was observed: The experimental group showed significant improvements in the Achieved level across all dimensions. Specifically, in the Digital Content Creation dimension, the experimental group improved from 3.3% to 76.7% at the Achieved level; for Safety, they improved from 6.7% to 83.3%; and for Problem-Solving, they improved from 6.7% to 83.3%. These results suggest that gamification effectively facilitated the transition to

advanced digital competencies, by promoting both learning and the practical application of digital skills. In contrast, the control group shows minimal improvements and, in some cases, declines, which reflects the limited efficacy of traditional methodologies compared with innovative strategies such as gamification. This evidence is crucial for redefining pedagogical approaches and integrating interactive technologies in teacher training, and highlighting the importance of playful strategies for professional development in educational contexts.

Table 2. Application of gamification to develop the variable digital competencies in regular basic education teachers: Mann-Whitney U test in the evaluation phase

Variable: Digital competencies				
Values	**Group**	**Range Average**	**Mann-Whitney U test**	**Significance**
Pretest	Control	32.9	379.5	$p = 0.297 > 0.05$
	Experimental	28.2		Not significant
Posttest	Control	18.7	96.5	$p = .000 < 0.05$
	Experimental	42.3		Significant
Dimension: Communication and collaboration				
Pretest	Control	32.4	394.5	$p = .411 > 0.05$
	Experimental	28.7		Not significant
Posttest	Control	20.8	158	$p = .000<0.05$
	Experimental	40.2		Significant
Dimension: Digital content creation				
Pretest	Control	32.5	391	$p = .382 > 0.05$
	Experimental	28.5		Not significant
Posttest	Control	19.2	110	$p = .000 < 0.05$
	Experimental	41.8		Significant
Dimension: Information and information literacy				
Pretest	Control	34.1	342.5	$p = .111 > 0.05$
	Experimental	26.9		Not significant
Posttest	Control	20.5	151	$p = .000 < 0.05$
	Experimental	40.5		Significant
Dimension: Problem-solving				
Pretest	Control	33.5	360	$p = 0.182 > 0.05$
	Experimental	27.5		Not significant
Posttest	Control	18.4	86	$p=0.000<0.05$
	Experimental	42.6		Significant
Dimension: Safety				
Pretest	Control	30.4	445.5	$p = .947 > 0.05$
	Experimental	30.7		Not significant
Posttest	Control	18.6	94	$p = .000<0.05$
	Experimental	42.4		Significant

Note. Information taken from the application of the instrument (a questionnaire to measure the level of digital teaching competence).

The results in Table 2 show that gamification had a positive and significant effect on various dimensions of the digital competencies of primary school teachers. In

the pretest phase, no significant differences were found between the control and experimental groups in any of the evaluated dimensions, as all p values were greater than .05 ($p > .05$), indicating that the two groups had similar skills before the intervention. However, in the posttest phase, a considerable improvement could be observed in the experimental group in all the evaluated dimensions (digital competencies, communication and collaboration, digital content creation, information and information literacy, problem-solving, and safety). In all cases, the average ranks of the experimental group were significantly greater than those of the control group, with p values less than .05 ($p < .05$) indicating statistically significant differences. These results suggest that gamification is an effective strategy for improving digital competencies of primary school teachers.

5. Discussion

The general objective of this study was to determine the extent to which gamification develops the digital competence of a group of regular basic education teachers in Trujillo, Peru, in 2024. The results indicate that the implementation of gamification strategies had a positive and statistically significant effect on the development of digital competencies of the participating teachers.

Inferential data analysis reveals that, after the intervention, there was a statistically significant difference between the experimental and control groups (Mann-Whitney U test = 96.5, $p < .05$). This result confirms that gamification had a significant effect on the development of teachers' digital competencies. By the end of the study, a total of 93.3% of the teachers in the experimental group had reached the Achieved level in digital competencies, whereas only 30% in the control group had reached this level. This finding aligns with those of other studies, such as that of Kopcha et al. (2016), who report significant improvements in teachers' self-efficacy and technology skills after the implementation of gamified training programs. The magnitude of the improvement observed in the present study suggests that gamification can be a particularly effective strategy for addressing the digital competence gaps identified in the Peruvian context by studies such as the OECD (2022).

With respect to the dimension of information and information literacy, the results show considerable progress in the experimental group, with an increase from 16.7% to 80% at the Achieved level. Inferential analysis confirms that this difference was statistically significant (Mann-Whitney U test = 151, $p < .05$). This progress is consistent with the findings of Hsu and Lin (2017), who report significant improvements in teachers' skills in using Web 2.0 tools after implementing a gamified system. The improvement in this dimension is particularly relevant because the ability to navigate and evaluate digital information is essential for teaching practice in the digital age.

In terms of the communication and collaboration dimension, there was an increase from 6.7% to 80% at the Achieved level in the experimental group. Statistical analysis confirms that this difference is significant (Mann-Whitney U test = 158, $p < .05$). This result aligns with the findings of Palazón-Herrera (2021), who reports increased participation and quality of online interactions by trainee

teachers through the use of gamified strategies. The improvement in this dimension suggests that gamification can be effective for fostering digital collaboration skills, which are crucial in today's education context.

In the dimension of digital content creation, the most notable improvement was recorded, from 3.3% to 76.7% at the Achieved level by the experimental group. This difference was statistically significant (Mann-Whitney U test = 110, $p < .05$). This result is particularly significant considering that, according to the OECD report (2022), only 10% of teachers in Peru performed at an adequate level in this area. The marked improvement in this dimension suggests that gamification can be particularly effective for developing digital content production skills, which is an increasingly important aspect of modern teaching practice.

With respect to the safety dimension, there was an increase from 6.7% to 83.3% at the Achieved level in the experimental group, with a statistically significant difference (Mann-Whitney U test = 94, $p < .05$). This improvement is particularly important considering the growing importance of cybersecurity and data protection in the education field. The improvement in this dimension suggests that gamification can be an effective tool to address the digital security concerns identified by previous studies, such as that of Voogt et al. (2018).

Finally, in the problem-solving dimension, the experimental group showed an improvement from 6.7% to 83.3% at the Achieved level; this difference is statistically significant (Mann-Whitney U test = 86, $p <.05$). This result is consistent with the findings of Tsai et al. (2020), who report significant improvements in problem-solving skills through the use of a gamified adaptive learning system. The improvement in this dimension suggests that gamification can be effective in developing critical thinking and problem-solving skills in digital contexts.

While the experimental group showed significant improvements in all dimensions, the control group exhibited minimal changes and even some regressions. This contrast, supported by statistically significant results in all dimensions, underscores the limited effectiveness of traditional teacher training methods for digital competencies, which is a challenge identified by Instefjord and Munthe (2017) and which became even more evident during the COVID-19 pandemic (König et al., 2020).

In conclusion, the results of this study, which are supported by robust statistical analyses, provide strong evidence of the effectiveness of gamification as a strategy to develop digital competencies in regular basic education teachers in the Peruvian context. These findings have important implications for education policy and teacher training, by suggesting that incorporating gamification elements into professional development programs could be an effective strategy to bridge the digital competence gaps identified by previous studies. However, additional research is needed to evaluate the long-term retention of the acquired competencies and their application in everyday teaching practice.

5.1. Theoretical and Practical Implications

From a theoretical perspective, this research contributes substantially to the conceptual framework of gamification in education contexts. The findings provide empirical evidence to support and expand the postulates of Deterding et al. (2011) and Kapp (2012) regarding the effectiveness of gamification, by extending them specifically to the realm of teacher training in digital competencies. Additionally, the study enriches our understanding and operationalization of the DigCompEdu proposed by Redecker (2017), by offering insights into how gamification differentially impacts various dimensions of teachers' digital competence.

The research also strengthens the intersection between learning theories and gamification, by providing evidence that supports integrating constructivist and connectivist principles into the design of gamified interventions for teacher training, in line with the proposals of Siemens (2005). Moreover, by contextualizing the research in a Latin American setting, the study contributes to the literature on teachers' digital competencies in the region, by offering valuable empirical data for future research and theoretical developments.

Practically, the results of this study have direct implications for the design and implementation of teacher training programs. The demonstrated effectiveness of gamification suggests that incorporating it into professional development programs could be an effective strategy for improving teachers' digital competencies. This could influence education policies, and direct resource allocation toward the implementation and scaling of gamified training programs at national levels.

The findings can also guide the development of gamified educational tools and platforms that are specifically designed for teacher training in digital competencies, by considering the particularities of each evaluated dimension. Furthermore, the approach used by this study to evaluate teachers' digital competencies could serve as a model for developing more effective and context-specific assessment tools in the Latin American education field.

The research underscores the importance of incorporating gamification strategies and digital competency development in initial teacher training programs to prepare future educators for the challenges of the digital age. Additionally, the demonstrated effectiveness of gamification has practical implications for preparing teachers for crisis situations that require a rapid transition to online teaching, such as that experienced during the COVID-19 pandemic.

Thus, the relevance and potential impact of this study in the fields of teacher training and digital competency development are emphasized. The results provide a solid foundation for future research and practical applications in the education context, and offers valuable guidance for researchers, teacher trainers, and policymakers in their efforts to enhance educators' digital competencies in the digital age.

6. Conclusion

This research on the impact of gamification on the development of digital competencies of teachers in regular basic education in Trujillo, Peru, yielded significant findings. The study conclusively demonstrates that the implementation of gamification strategies has a positive and statistically significant effect on the development of teachers' digital competencies. Substantial improvements were observed across all the evaluated dimensions of digital competency, which suggests that gamification, when properly designed and implemented, can comprehensively address the various facets of teachers' digital skills.

This research also makes an important methodological contribution by providing a robust and replicable model for future studies in similar contexts. Additionally, it underscores the importance of considering motivational and engagement factors in the design of teacher training programs.

However, the study has several limitations. The relatively small sample size and the specific context of Trujillo, Peru, restrict the generalizability of the findings. Furthermore, the research focused on the short-term effects of the gamified intervention.

Longitudinal studies are recommended to assess the long-term retention and application of acquired digital competencies. It would also be valuable to explore the effectiveness of gamification in different cultural contexts and educational levels in Latin America.

The recommendations include the implementation of professional development programs based on gamification, the development of regulatory frameworks that promote the integration of gamification strategies into teacher training at the national level, and the active participation of teachers in gamified professional development programs. These measures could significantly enhance teachers' digital competencies and, ultimately, improve the quality of education in the digital era.

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